Geophysical signatures of copper-gold porphyry and epithermal gold deposits, and implications for exploration

Thesis submitted by

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ABSTRACT

Geophysical data are presented for a number of deposits including the Batu Hijau, Elang, Grasberg, and Alumbrera porphyry copper-gold deposits; the Martabe and Yanacocha high sulphidation epithermal gold deposits; and the Pajingo and Waihi low sulphidation epithermal gold deposits. The physical properties of the mineralisation and alteration are discussed with an emphasis on those properties that can be measured with standard exploration techniques.

Mineralisation in porphyry Cu-Au deposits is commonly associated with magnetite that can produce strong discrete magnetic anomalies. This is usually within a zone of magnetite-destructive alteration that can be identified with a high resolution magnetic survey. Magnetic surveys are also useful in defining regional structure and geology in the porphyry environment. Strong chargeabilities due to sulphides are typically associated with porphyry systems. Mineralisation and clay-pyrite alteration can produce strong anomalies, and late stage and post mineral intrusions can be mapped as chargeability lows within the system. These systems may be more conductive than the host rocks because of clay-pyrite alteration and sulphide veining, and airborne EM can be useful in locating and defining their extent. Gravity, radiometrics, remote sensing and topography may also be useful in exploration for porphyry Cu-Au deposits.

In high sulphidation epithermal systems gold is commonly associated with massive silica alteration. This alteration results in resistivities in the order of thousands of ohm-meters compared with background resistivities of tens of ohm-meters in argillic and propylitic alteration. Both ground resistivity and airborne EM surveys have been successful in locating and defining these deposits. Alteration in high sulphidation epithermal deposits is magnetite destructive over a large area, although it does not appear to have a large vertical extent as the subdued character of the underlying lithologies can be observed.

Typically, gold in low sulphidation epithermal deposits is in thin quartz veins that are associated with major structures. The alteration associated with the veins is magnetite destructive, and high resolution magnetics can be a very useful and cost-effective technique to map the structures and alteration. Some deposits are associated with broad zones of magnetite destruction which is apparent in the regional magnetics. The mineralised quartz veins are within broader zones of

silicification, and resistivity surveying can be used to map these zones. Generally, the high resistivity zones due to silicification are coincident with the structures identified in the magnetics.

High resolution magnetics and electrical surveys are the most useful geophysical techniques in exploration for porphyry and epithermal deposits. Airborne magnetic and EM surveys are fast and cost effective, particularly in areas of rugged topography. Regional magnetics, gravity, remote sensed data and topographic data can also be used to identify major structures, intrusive complexes and alteration. Radiometric surveys can be useful in mapping geology and alteration.

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